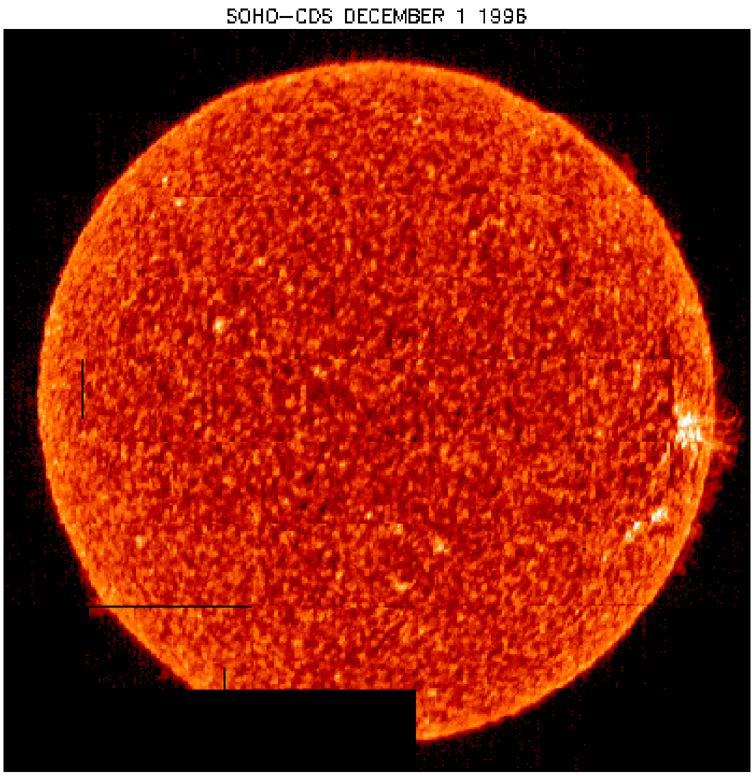
The Quiet Sun from SOHO-CDS



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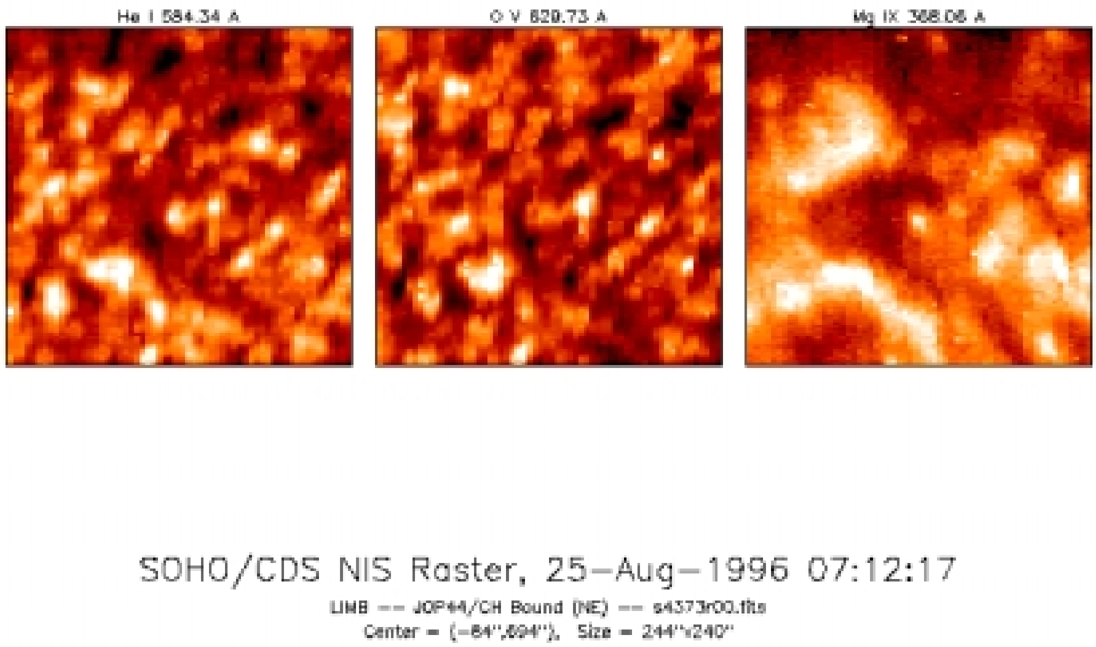
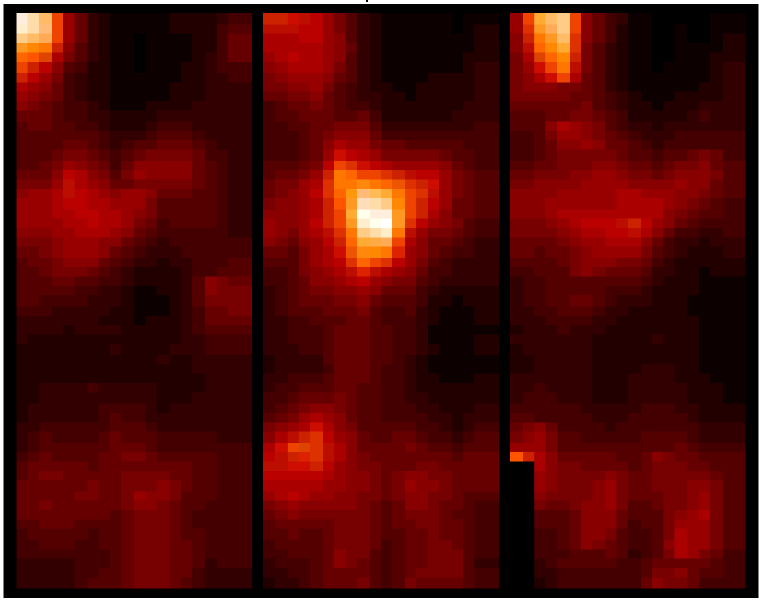
The Quiet Sun Story

The full Sun image shown above was taken by the Coronal Diagnostic Spectrometer (CDS) instrument on the ESA/NASA Solar and Heliospheric Observatory (SOHO) spacecraft on December 1st, 1996 - when solar activity was relatively low. The image, taken in light emitted from oxygen in the Sun’s atmosphere (O V at 629 Angstrom) shows gases at 250,000 degrees. The image is dominated by the so-called supergranulation. Like a 3-dimensional pan of boiling water, this is the influence of convection motion in the body of the Sun as hot gases rise up to the surface and cooler gases descend.



A close up of a particular region can be seen in this image which shows a snapshot of a piece of non-active Sun in extreme ultraviolet light showing radiation from helium, oxygen and magnesium in the Sun's atmosphere (He I 584 A, O V 629 A and Mg IX 368 A). They are effectively mapping the gases at 20,000, 250,000 and 1 million degrees, from left to right. These images show the same 200,000 x 200,000 km area of the Sun's disc at the same time. They represent different layers in the Sun's atmosphere. The 'cooler' images, which are showing the lower atmosphere, show the supergranulation well and display many bright patches. These bright patches are, in fact, highly variable and are the sites of transient flashes known as blinkers.



An example of one of these flashes or blinkers is shown here. The images are showing gases at 250,000 degrees in the Sun's atmosphere and show the same 30,000 km by 74,000 km area. We are simply looking straight down onto a piece of the quiet Sun. The three images were taken by CDS on December 4th, 1997, and were taken at 19:15, 19:39 and 19:49 GMT or Universal Time. Some bright patterns can be seen, and these relate to the supergranulation, but the striking feature is the blinker, a bright explosion the size of the Earth which lights up the middle of the centre image, but was not evident shortly before or after the event. This event is typical of the blinkers that have been seen.

Images and movies such as these demonstrate that the flashes occur over the entire disc and that each one may last for many minutes. There may be 3000 on the solar disc at anypoint in time. They may look rather insignificant yet they represent a 'disease' which covers the entire Sun. Such a 'global' coverage of flashes must represent a transient process at work in the Sun's atmosphere which is basic to the way in which the Sun's atmosphere works.

The Sun's atmosphere still retains many secrets. One major mystery relates to why the Sun's atmosphere achieves temperatures of up to 2 million degrees - yet the Sun's surface is only 6,000 degrees. What heats the solar atmosphere to such dramatic temperatures? Also, there is a continuous flow of gas, the so-called solar wind, streaming from the Sun into space. How does this gas become accelerated, why does it stream into space? The blinker events may be pockets in the Sun's atmosphere where relatively small explosions dump energy into the solar gases. Given the number of blinker events, the net effect may be sufficient to heat the corona and accelerate the solar wind. If this is the case then the blinker discovery may be providing some answers to some longstanding questions.

The underlying driver for the blinker events must be the Sun's complex magnetic fields. The upwelling gases in the body of the Sun bring magnetic fields to the surface, which are generated by the motions of charged particles in the Sun. The turbulent convective motion drives a complex magnetic 'carpet', the discovery of which was recently announced by colleagues from the MDI instrument on SOHO. This 'carpet' consists of a complex web of magnetic fields low in the Sun's atmosphere, which are continually moving due to the motions of gases in the Sun. Like a continuously moving mass of spaghetti or elastic bands, one might well expect many sites where the magnetic fields are driven to a state of some complexity. Unlike elastic bands which may break, magnetic field lines can reform or reconnect and in doing so can dump energy into the solar gases. This kind of process is most likely to be responsible for the blinker events.

The blinker explosions may be the size of the Earth, and there may by 3000 of them at any point in time, but by solar standards they are small and their thermal energy content is not great. Calculations show that each event may contain 10 million, million, million Joules of energy, i.e. equivalent to a 100 Megaton bomb (100 million tonnes of TNT), in thermal energy. This alone is not sufficient energy to power the solar wind or to heat the solar corona. However, this is just a calculation of the thermal energy contained in these events, and energy may well be released in other forms during these events. In short, the discovery of the magnetic carpet and the blinkers is generating a lot of excitement because we are identifying processes which occur over the entire solar disc and many believe that there must be an intimate relationship between these and the coronal heating and/or solar wind problems. The significance of these events is now being investigated in earnest.

Early papers (postscript form) can be obtained by clicking here:

R.A. Harrison, 1997, Solar Phys. 175, part 2

R.A. Harrison, 1997, ESA SP-404 (Proc 5th SOHO Workshop), p7

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